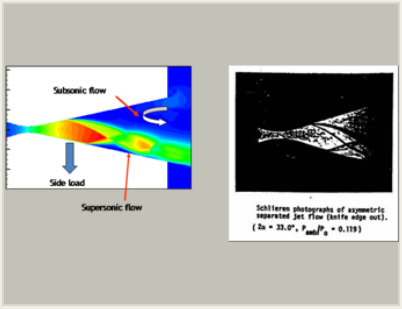
Elimination of Rocket Ignition Side Loads, Phase I

Completed Technology Project (2016 - 2016)

Project Introduction

This proposal is responsive to Topic H10: Ground Processing and in particular to Subtopic H10.02. When a rocket motor/engine is ignited at low altitude its convergent/divergent nozzle experiences significant impulses across the nozzle; these impulses are known as "ignition side loads" (ISL). The ISL duration ranges from a few tenths of a second for small nozzles, to as long as several seconds for very large nozzles. These large-amplitude ISLs are transient, chaotic, and develop during the chamber pressure rise when the over-expanded nozzle is partially empty. The ISL peak amplitude in large rockets can be as high as 70% of the nominal thrust. The ISL has caused problems in most rocket engine development programs, from pulling off engines from gimbals during their testing, to causing cooling engine lines cracks, knocking off instrumentation, and a large variety of other ISL related issues. ISLs are also experienced during hot staging of launchers and missiles. The current models for predicting ISLs result in very conservative estimates for the TVC actuators and nozzle throat structures, and impact negatively on development schedule, cost, and engine weight. The proposed work for Phase I will demonstrate the feasibility of eliminating for the first time the ISL by developing a set of methods and procedures that will show by CFD simulation how to effectively reduce the ISL to a negligible level. The innovation consists of a set of devices installed precisely within the nozzle that stabilize the flow during the start up pressure rise and thus eliminate the ISL. These inserts are present ONLY during the brief period of rocket ignition and chamber pressure ramp-up. Once the rocket chamber reaches the nominal pressure in a short time, they ablate away and the nozzle configuration geometry returns to the intended high performance design. By implementing this innovation, the ISL risk is eliminated altogether, thus greatly simplifying engine/motor development.



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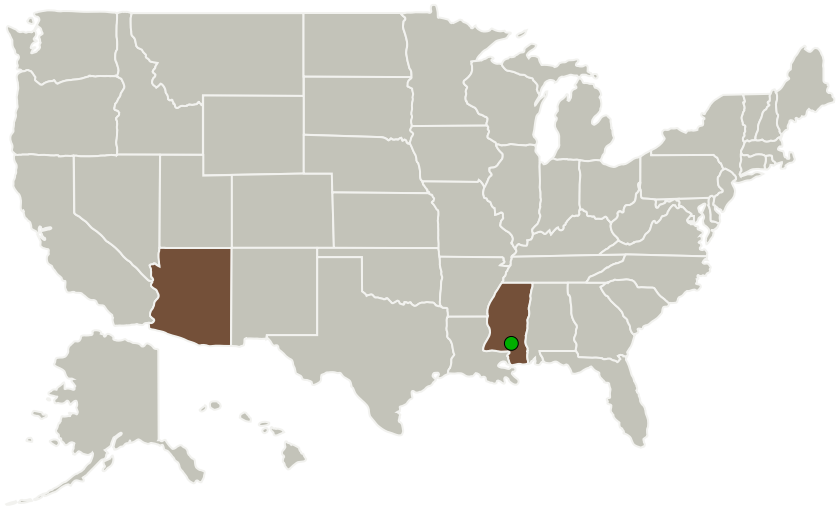
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Arizona Systems Engineering Group, LLC.	Lead Organization	Industry	Tucson, Arizona
Stennis Space Center(SSC)	Supporting Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations	
Arizona	Mississippi

Project Transitions

June 2016: Project Start

December 2016: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/139780)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Arizona Systems Engineering Group, LLC.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

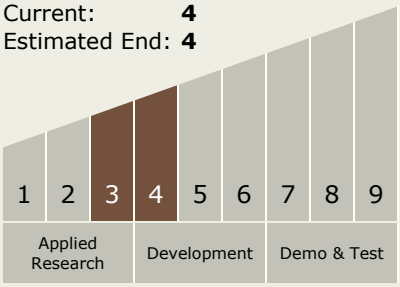
Carlos Torrez

Principal Investigator:

Jose E Chirivella

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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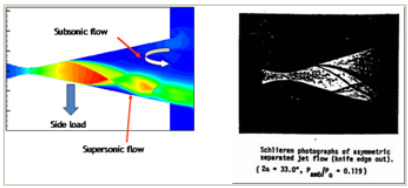
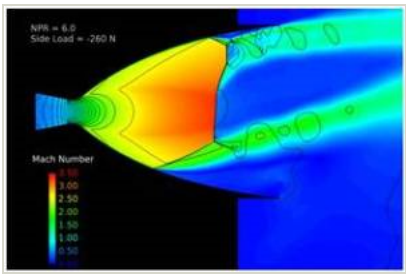
Images



Briefing Chart Image
ELIMINATION OF ROCKET IGNITION SIDE LOADS, Phase I
(https://techport.nasa.gov/image/135420)



Final Summary Chart Image
ELIMINATION OF ROCKET IGNITION SIDE LOADS, Phase I Project Image
(https://techport.nasa.gov/image/128204)

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.3 Cryogenic

Target Destinations

Earth, The Moon, Others Inside the Solar System, Outside the Solar System, The Sun, Mars